ENVIRONMENTAL SAMPLE CHEMICAL ANALYSIS AUTOMATION PROJECT

TECHNOLOGY DESCRIPTION

The U.S. Department of Energy (DOE) Chemical Analysis Automation (CAA) Project is developing a flexible, plug-and-play approach to automating chemical analyses and regulatory compliant, chemical analysis procedures to reduce the cost and increase the efficiency of environmental management activities at DOE sites. This project is a collaboration between Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Idaho National Engineering and Environmental Laboratory (INEEL), and Advanced Power Technologies, Inc. (APTI) of Washington, D.C. During the past seven years, the CAA Project has developed most of the elements essential to such an automated analysis system. The initial focus of the project was to automate the chemical analysis of the organic constituents identified in the Resource Conservation and Recovery Act (RCRA) and related regulations. Later, work at automating the chemical analysis of the metals designated by RCRA as hazardous was added.

TECHNOLOGY NEED

The DOE complex has an enormous environmental cleanup problem that is estimated to cost on the order of $200 billion before it is completed sometime in the next century. The Department of Defense (DoD) has related problems of similar magnitude, but with differing contaminants. Key to managing these environmental liabilities is developing a way to efficiently conduct numerous chemical analyses of the contaminants in soils, waters, and sludges at DOE sites. These analyses are required for site characterization, site remediation, and post-cleanup monitoring. Specifically, the CAA technology addresses the following DOE Site Technology Coordinating Group (STCG) needs:

- SR99-1003 - Improvements to Physical, Chemical, and Radionuclide Quantification of Solid Waste
- RL-WT065 - Direct Inorganic and Organic Analyses of High-Level Waste
- RF-DD02 - High Speed, Integrated Characterization System for Radioactive, Hazardous, and Toxic Contamination
- ID-6.1.02 - Real-Time Field Instrumentation for Characterization and Monitoring of Soils and Groundwater
- CAO-99-05 - Automated Data Review and Validation
- AL-09-01-05-MW - Mobile Analysis Methods for Hazardous Metals in TRU Waste

Regulations governing environmental restoration place stringent requirements on the analytical methods used for chemical analysis. Specified procedures, such as those formalized by the U.S. Environmental Protection Agency (EPA) as SW 846 (Solid Waste) methods create an opportunity for automating chemical analysis to:

- Improve data quality through the consistency resulting from an automated operation.
- Reduce sample analysis turn-around time for more efficient decision-making.
- Reduce analysis and remediation costs.
- Improve worker safety by reducing exposure to hazardous chemicals.
- Reduce waste volumes by capturing and recycling solvents.

TECHNOLOGY BENEFITS

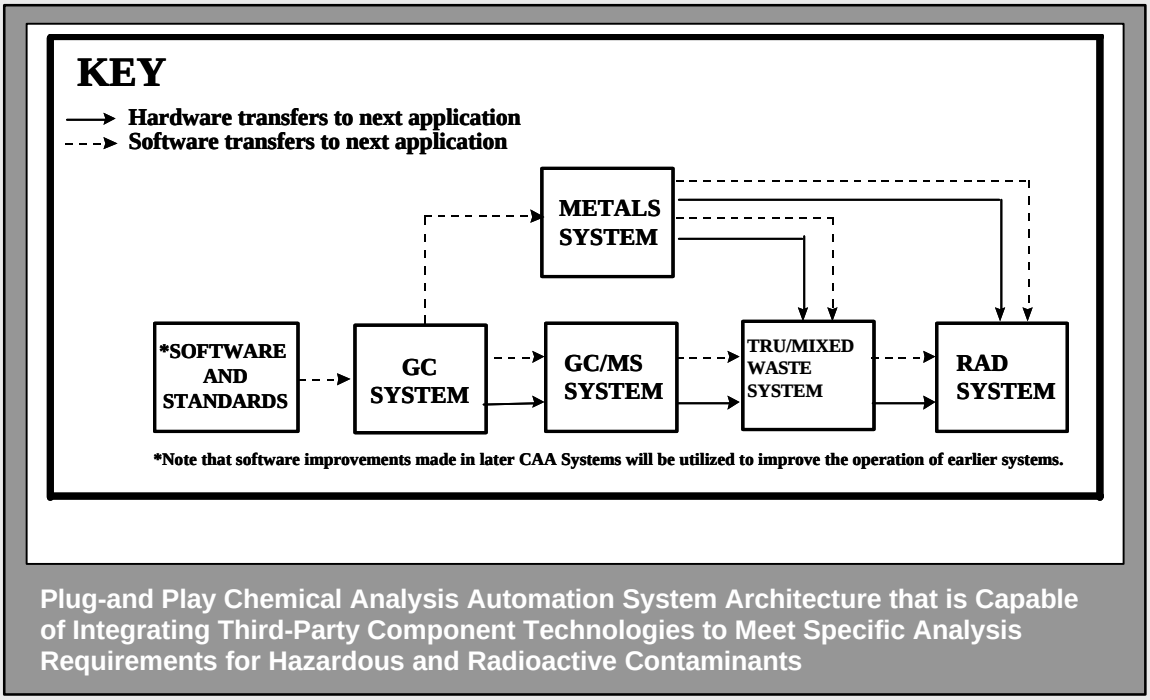
A 30-day sample turn-around time for routine, high-volume chemical analyses is typical of today's commercial practice. Achieving a less than 24-hour turn-around time is possible with the technology being developed by the CAA Project. CAA technology is expected to reduce remediation project operating costs by 10 to 15 percent or more, primarily by reducing the need to process additional samples

collected in areas determined to be uncontaminated that would not otherwise be identified until much later because of the slow commercial sample analysis turn-around time involved.

TECHNOLOGY CAPABILITIES/LIMITATIONS

The fundamental building block being developed by the CAA Project is a software system capable of managing a wide array of user-specified analyses. Technologies being developed by the CAA Project include the following:

- A number of sample preparation hardware modules.
- Component communication and interface standards.
- Specialized system software.
- A fully automated organics analysis system.
- A fully automated metals analysis system.



Plug-and Play Chemical Analysis Automation System Architecture that is Capable of Integrating Third-Party Component Technologies to Meet Specific Analysis Requirements for Hazardous and Radioactive Contaminants

COLLABORATION/TECHNOLOGY TRANSFER

For CAA to be of widespread cost-reduction benefit to DOE, a number of different CAA systems will have to be provided to various entities involved in DOE environmental management activities. Providing a number of low-cost systems along with related support services is beyond the charter of the national laboratories. A Cooperative Research and Development Agreement (CRADA) with APTI will facilitate needed CAA commercialization.

ACCOMPLISHMENTS AND ONGOING WORK

The Witherspoon Landfill 1630 Site located in Knoxville, Tennessee, is a 48-acre site that was operated as an unregulated landfill from the 1950s until 1974. Operating under an Atomic Energy Commission License from 1966 to 1969, this site was used to dispose of scrap metal contaminated with less than one percent of natural and depleted uranium.

The CAA project analyzed field-splits of 234 surface soil samples for polychlorinated biphenyls (PCBs) using the developmental PCB standard analysis method (SAM) system located in the CAA Mobile

Environmental Laboratory at ORNL. A total of 340 extracts and 870 gas chromatograph (GC) injections were performed through the automated system in 24 single-shift days with detection of PCBs in 60 percent of the samples. Only 5 samples (1.4 percent) were lost due to nonrecoverable errors, and no reruns were associated with "health/safety" or "lost/inaccurate documentation" issues. The tracking capability of the Task Sequence Control (TSC) provided detailed documentation as to method compliance; e.g., extraction times/temperature, solvent volumes, and concentration steps. The CAA system was demonstrated to eliminate documentation errors associated with manual recording of the information from various steps of a total method, and to produce data output meeting the EPA Level-IV data package requirements.

The CAA system performed well for PCB analysis. The Analytical Service Organization at the Oak Ridge Site estimated this project would have required a chemist and three laboratory technicians working 21 10-hour days. Thus, the Witherspoon experience demonstrated the potential benefits of the CAA; i.e., reduced costs and increased throughput.

The FY 1999 scope of activities is to complete development of the CAA system for semi-volatile organic analyses (SVOA) and to complete demonstration of the utility and performance merits of a fully integrated CAA-SVOA system at the Savannah River Site (SRS).

Publications/Presentations/Patents/Copyrights:

- 4 patents have been issued for the CAA technology.
- 36 copyrights have been asserted on CAA software, drawings, and standards documentation.
- 55 oral presentations on CAA technology have been made at technical meetings.
- 46 papers and reports related to CAA technology have been published.
- 7 technical sessions with CAA technology as a major component were organized at professional meetings.

TECHNICAL TASK PLAN (TTP) INFORMATION

TTP No./Title: AL19C231 - Chemical Analysis Automation
TTP No./Title: ID79C231 - Chemical Analysis Automation
TTP No./Title: OR09C231 - Chemical Analysis Automation

CONTACTS

Jerry Boak
Principal Investigator
Los Alamos National Laboratory
P.O. Box 1663, MS: J591
Los Alamos, NM 87545
(505) 667-0835 Fax: 665-7238
jmboak@lanl.gov

Pamela Saxman
Technical Program Officer
U.S. Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87185-5400
(505) 845-6101 Fax: -5960
psaxman@doeal.gov